Revised per Munch meeting 24 May 2000. Also revised 31 May 00. LCH removed change tracking. JH provided revised words for 25.561(c) and (c)(2) cargo in cargo compartments and re-orderd 25.721.

DRAFT– NOT FOR PUBLIC RELEASE. Dated 31 May 2000

[4910-13]

DEPARTMENT OF TRANSPORTATION

Federal Aviation Administration

[14 CFR part 25]

[Docket No. ; Notice No.]

RIN:

Revised Requirements for the Structural Integrity of Fuel Tanks

AGENCY: Federal Aviation Administration, DOT.

ACTION: Notice of proposed rulemaking.

SUMMARY: This notice proposes to revise the fuel tank design requirements of the Federal Aviation Regulations (FAR) for transport category airplanes to require that fuel tanks are designed for fuel pressures arising from emergency landing conditions. The proposals also include consideration of fuel tank ruptures due to the aircraft impacting on and subsequently sliding along the ground with all combinations of landing gears not extended and due to an engine pylon or engine mounting or landing gear tearing away. These actions would ensure that fuel tanks would be able to resist rupture and retain fuel under emergency landing conditions, thus increasing safety by reducing the risk of a post crash fire. This proposal has been developed in co-operation with the Joint Aviation Authorities (JAA) of Europe and the U.S., Canadian and European aviation industries through the Aviation Rulemaking Advisory Committee (ARAC).

DATES: Comments must be received on or before [insert a date 120 days after the date of publication in the Federal Register]

ADDRESSES: Comments on this notice may be mailed in triplicate to: Federal Aviation Administration (FAA), Office of the Chief Counsel, Attention: Rules Docket (AGC-10), Docket No. , 800 Independence Avenue SW., Washington, DC 20591; or delivered in triplicate to: Room 915G, 800 Independence Avenue SW., Washington, DC 20591. Comments delivered must be marked Docket No. . Comments may also be submitted electronically to nprmcmts@mail.hq.faa.gov. Comments may be examined in Room 915G weekdays, except Federal holidays, between 8:30 a.m. and 5:00 p.m. In addition, the FAA is maintaining an

information docket of comments in the Transport Airplane Directorate (ANM-100), FAA, 1601 Lind Avenue SW., Renton, WA 98055-4056. Comments in the information docket may be examined weekdays, except Federal holidays, between 7:30 a.m. and 4:00 p.m.

FOR FURTHER INFORMATION CONTACT: James Haynes, Airframe and Propulsion Branch, ANM-112, Transport Airplane Directorate, Aircraft Certification Service, FAA, 1601 Lind Avenue, SW., Renton, WA 98055-4056; telephone (206) 227-2131.

SUPPLEMENTARY INFORMATION

Comments Invited

Interested persons are invited to participate in this proposed rulemaking by submitting such written data, views, or arguments as they may desire. Comments relating to any environmental, energy, or economic impact that might result from adopting the proposals contained in this notice are invited. Substantive comments should be accompanied by cost estimates. Commenters should identify the regulatory docket or notice number and submit comments in triplicate to the Rules Docket address above. All comments received on or before the closing date for comments will be considered by the Administrator before taking action on this proposed rulemaking. The proposals contained in this notice may be changed in light of comments received. All comments received will be available in the Rules Docket, both before and after the comment period closing date, for examination by interested persons. A report summarizing each substantive public contact with FAA personnel concerning this rulemaking will be filed in the docket. Persons wishing the FAA to acknowledge receipt of their comments must submit with those comments a self-addressed, stamped postcard on which the following statement is made: "Comments to Docket No. ____." The postcard will be date stamped and returned to the commenter.

Availability of NPRM

An electronic copy of this document may be downloaded using a modem and suitable communications software from the FAA regulations section of the Fedworld electronic bulletin board service (telephone: 703-321-3339), the Federal Register's electronic bulletin board service (telephone: 202-512-1661), or the FAA's Aviation Rulemaking Advisory Committee Bulletin Board service (telephone: 202-267-5984).

Internet users may reach the FAA's web page at http://www.faa.gov or the Federal Register's web page at http://www.access.gpo/su_docs for access to recently published rulemaking documents.

Any person may obtain a copy of this notice by submitting a request to the Federal Aviation Administration, Office Rulemaking, ARM-1, 800 Independence Avenue SW., Washington, DC 20591; or by calling (202) 267-9680. Communications must identify the notice number of this NPRM. Persons interested in being placed on a mailing list for future rulemaking documents should also request a copy of Advisory Circular No. 11-2A, Notice of Proposed Rulemaking Distribution System, that describes the application procedures.

Background

The manufacturing, marketing and certification of transport airplanes is increasingly an international endeavor. In order for U. S. manufacturers to export transport airplanes to other countries the airplane must be designed to comply, not only with the U.S. airworthiness requirements for transport airplanes (14 CFR part 25), but also with the airworthiness requirements of the countries to which the airplane is to be exported.

The European countries have developed a common airworthiness code for transport airplanes that is administered by the Joint Aviation Authorities (JAA) of Europe. This code is the result of a European effort to harmonize the various airworthiness codes of the European countries and is called the Joint Aviation Requirements (JAR)-25. It was developed in a format similar to 14 CFR part 25. Many other countries have airworthiness codes that are aligned closely to 14 CFR part 25 or to JAR-25, or they use these codes directly for their own certification purposes. Since 1988, the FAA and JAA have been working toward complete harmonization of JAR-25 and 14 CFR part 25.

The Aviation Rulemaking Advisory Committee (ARAC) was established by the FAA on February 15, 1991, with the purpose of providing information, advice, and recommendations to be considered in rulemaking activities. The FAA and JAA are continuing to work toward the harmonization of JAR-25 and 14 CFR part 25 by assigning ARAC specific tasks. By notice in the Federal Register (59 FR 30081, March 15, 1993), the FAA assigned several tasks to an ARAC Working Group of industry and government structural loads specialists from Europe, the United States, and Canada. Task 1 of this charter included design requirements for the strength of fuel

tanks. Subsequently, by notice in the Federal Register (63 FR 45895, August 27, 1998) the FAA chartered the same group of specialists with additional related aspects of fuel tank protection. Task 15 of this charter included the design and construction aspects of fuel tank protection from landing gear failures including wheels-up landing conditions (§§ 25.721 and 25.994). The assigned tasks were to review the current requirements for fuel tanks in 14 CFR part 25 and JAR-25 in order to define harmonized regulations that would be suitable for inclusion in both 14 CFR part 25 and JAR-25. The ARAC Loads and Dynamics Harmonization working group has completed its work for this task and has made recommendations to the FAA by letter dated

_____.

The existing § 25.963(d) includes a requirement to account for fuel inertia loads in the design of fuel tanks within the fuselage contour, and requires those tanks to be protected such that they are not exposed to scraping action with the ground. JAR-25 has the same requirement, but annotated as JAR 25.963(e). In addition JAR 25.963(d) specifies design requirements for all fuel tanks that, if ruptured, could release fuel in or near the fuselage or near the engines in quantities sufficient to start a serious fire. Section 25.721 contains conditions to protect fuel tanks from the effects of a landing gear breaking away and also to protect fuel tanks in a wheels-up landing. Section 25.994 contains a requirement to protect fuel systems and components in engine nacelles and the fuselage in a wheels-up landing on a paved runway. Although §§25.721 and 25.994 are identical in the JAR and FAR, there have been differences in interpretations and application of these requirements between and within the civil aviation authorities.

The current 14 CFR part 25 airworthiness standards § 25.963(d) prescribe conditions that the structure of fuel tanks located within the fuselage contour must be designed to withstand during an emergency landing. These conditions cover the resistance to the inertia forces prescribed by § 25.561 and protection such that exposure to scraping action with the ground is unlikely. However, the rule does not apply to other fuel tanks, such as wing fuel tanks, that are outside the fuselage contour. Adequate strength and protection against rupture for fuel tanks outside the fuselage contour has been achieved on existing airplanes by application of other design requirements.

For many years the British Civil Airworthiness Requirements (BCAR) have included a design condition that requires fuel tanks inboard of the landing gear or inboard of, or adjacent to, the most outboard engine to have the strength to withstand fuel inertia loads appropriate to the emergency landing conditions. The BCAR also addresses protection of fuel tanks against rupture by the airplane sliding with its landing gear disarranged and against engine mounts tearing away. In developing the common European airworthiness requirements, the Joint Aviation Authorities (JAA) also recognized that crashworthiness criteria for wing fuel tanks is necessary to ensure an adequate level of safety and since October 1988, the European Joint Aviation Requirements (JAR-25) have included a design requirement for fuel tanks outside of the fuselage contour, that now supersedes the previously cited BCAR requirement.

Service experience with respect to rupture of fuel tanks due to fuel inertia pressure loads is good. From this service experience, it is concluded that current airplanes should have adequate strength to meet this condition. However, this may not always be the case, especially if new airplane designs are significantly different from past conventional configurations in terms of length and breadth of the wing fuel tanks, or design and location of engines, or other sources of ignition. Without specific emergency landing conditions for fuel tanks outside of the fuselage contour, the current fuel tank crashworthiness requirements may not guarantee that adequate levels of fuel tank structural integrity will always be present.

Section 25.721 "Landing gear – general", contains two design requirements. The first requirement in paragraph 25.721(a) was adopted by amendment 25-23 (35 FR 5665, April 8, 1970) and provides for protection of fuel systems from a landing gear breaking away. This is considered a local component design criterion to protect fuel tanks from rupture and puncture due to the failure of the landing gear and its supports. This requirement applies only to fuel systems inside the fuselage for airplanes with 9 seats or less and to all fuel systems for airplanes with 10 seats or more. Experience has shown that the landing gear malfunctions can lead to landing on the engine nacelles for some configurations, and this can result in the engine nacelle breaking away, creating much the same fuel tank rupture potential as the landing gear breaking away.

Paragraph 25.721(b) provides for the protection of fuel systems in a wheels-up landing due to any combination of gear not-extended. This condition is not intended to treat a collapsed gear condition, but is intended to cover cases in which one or more gear do not extend for

whatever reason and the airplane must make a controlled landing on a paved runway in this condition. This requirement only applies to airplanes with 10 seats or more. At the time this paragraph was adopted (amendment 25-32, 37 FR 3969, Feb 24, 1972), § 25.561 "Emergency landing conditions - General" contained a landing descent speed of 5 feet per second as an alternative criteria that could allow a reduction in the specified vertical emergency landing design load factor. This alternative was removed by amendment 25-64 (53 FR 17646, May 17, 1988) in order to make the specified vertical design load factor the minimum design condition. However, the 5 feet per second descent speed of § 25.561 had, by design practice and interpretation, become the design descent velocity for the wheels-up landing conditions of §§ 25.721 and 25.994. By removing it, the quantitative definition of the wheels-up landing condition on a paved runway was lost.

Section 25.994 was adopted by amendment 25-23 (35 FR 5665, April 8, 1970) and further revised by amendment 25-57 (49 FR 6848, Feb 23, 1984) to clarify that the wheels-up landing condition was on a paved runway. Advisory Circular 25.994-1 was also issued in July 24, 1986 which specifically referred to § 25.561 for the design conditions which at that time, contained the 5 feet per second landing descent criteria.

Discussion

Investigation of various types of accidents that result in high impact forces on the airframe shows that it is necessary to consider only three flight phases in which accidents could have a potential for occupant survival. These are final approach, landing and take-off.

In 1982, the National Aeronautics and Space Administration (NASA) completed a study, of commercial transport aircraft accidents. This study, reported in FAA Report No. DOT-FAA-CT-82-70, "Transport Aircraft Accident Dynamics" by A. Cominsky, records a total of 109 impact survivable accidents in the period between 1960-1980. The breakdown of these accidents is reproduced in Table 1. An impact survivable accident is defined by NASA as one in which there were fatalities, but not all occupants received fatal injuries as a result of impact forces imposed during the crash sequence. Since aircraft impact during approach is likely to be equivalent to the aircraft flying into the ground, FAA considers that this is too severe a condition to be the subject of design requirements. Nevertheless the figures for approach accidents are given in Table 1 for completeness.

TABLE 1

Injury Survey - Survivable Accidents

Period 1960 to 1980, Commercial Transport Aircraft

Accident Group	Number Of Accidents	Number of Passengers and Crew					
		Total	Injuries	Fatalities			
			Serious/ Minor/ None	Impact Trauma	Fire	Drowned	Unknown
Approach	27	2,113	1,078	434	298	15	288
Landing	33	3,058	2,637	157	227	23	14
Take-off	49	4,798	4,419	92	146	78	63
Total	109	9,969	8,134	683	671	116	365

A significant conclusion drawn from study of these accident statistics is that there are 50 percent more fatalities due to fire than to impact trauma in the survivable landing and take-off accidents. The FAA believes that it is proper, therefore, that post impact fire accidents merit attention in respect of airworthiness action aimed at protection of occupants.

In regard to § 25.963(d), ARAC has determined that the safety record with respect to fuel tank rupture due solely to fuel inertia loads is excellent. Manufacturers' records of accidents and serious incidents to large transport airplanes show no event where significant loss of fuel occurred due to fuel inertia pressure. Fuel losses that did occur were due mainly to direct impact and to puncturing by external objects.

Nevertheless, ARAC believes, and the FAA agrees, that a fuel inertia criterion for wing fuel tanks is still needed to ensure that future designs meet the same level of safety achieved by the current fleet. In setting an appropriate standard for this proposal, ARAC have reviewed the structural capability of the existing fleet. In that review it was shown that the outboard fuel tanks of a large part of the fleet could not be shown, theoretically, to be able to withstand the fuel inertia pressures generated by a wing full of fuel, combined with the emergency landing load factors of § 25.561(b)(3). In fact the wing fuel tanks of many aircraft types were designed to a simple criterion in which fuel pressure was calculated using an inertia head equal to the local geometrical streamwise distance between the fuel tank solid boundaries. Service experience has

shown this criterion to produce fuel tank designs with an acceptable safety level. Therefore it is appropriate that the future airworthiness standards for fuel tanks should require a similar level of design fuel pressure for similar fuel tank designs.

For fuel tanks within the fuselage contour, the existing fuel inertia load criterion as generally applied covers up to a full fuel tank, an inertia head equal to maximum pressure head, and inertia load factors equal to those of § 25.561(b)(3). ARAC believes, and the FAA accepts, that this level of rupture resistance for fuel tanks is entirely justified based upon occupant survivability considerations. Any fire occurring due to spilled fuel inside the fuselage poses an almost immediate threat to the occupants. Therefore the current minimum level of rupture resistance is proposed to be retained for fuel tanks within the fuselage contour. In this regard, the design factors specified for the fuel tank pressure boundaries inside the fuselage are equivalent to those that would be developed with the emergency landing load factors of § 25.561(b)(3). The phrase "within the fuselage contour" in paragraph 25.963(d) has been subject to a variety of interpretations in the past. Fuel tanks "not within the fuselage contour" are all fuel tanks where fuel spillage through any tank boundary would remain physically and environmentally isolated from occupied compartments by a barrier that is at least fire resistant. In this regard, cargo compartments that share the same environment with occupied compartments would be treated the same as if they were occupied.

ARAC has determined, and the FAA concurs, that the fuel pressure requirement of § 25.963(d) should not reference the emergency landing load factors of § 25.561(b)(3). The rationale is that the emergency landing load factors of § 25.561(b)(3) are based upon the restraint of fixed mass items and the response of a fluid during emergency landings is different and much more complex to quantify. Therefore, the proposed requirements for fuel tanks both within and outside of the fuselage contour have been simply formulated in terms of equations with factors that are justified based upon the satisfactory service experience of the existing fleet.

Section 25.721 would be completely rewritten to include a wheels up landing condition, an engine nacelle breakaway condition, and a landing gear breakaway condition. The new proposed paragraph 25.721(b) defines the descent velocity, airplane configurations, and sliding conditions for a wheels-up landing on a paved runway. Paragraph 25.721(c) would prescribe a new requirement for consideration of the engine nacelle(s) breaking away if they are likely to come

into contact with the ground in a wheels-up landing condition. The new proposed paragraph 25.721(a) would contain the landing gear breakaway condition which is similar to the existing landing gear breakaway condition except it would apply to all landing gear, not just the main gear, and it would apply to all transport airplanes without regard to seating capacity.

Section 25.994 would be revised to reference § 25.721(b) for the conditions that must be considered for the protection of fuel systems and components in engine nacelles and in the fuselage in a wheels-up landing on a paved runway.

Section 25.561(c) would be revised in order to provide a requirement to consider cargo in the cargo compartment. This revision would require that if cargo in the cargo compartment located below or forward of all occupants in the airplane were to break loose, it would be unlikely to penetrate fuel tanks or lines or cause fire or explosion hazards by damaging adjacent systems. The current requirement only addresses items of cargo in the passenger compartment.

The new proposed requirements for fuel tank protection would apply to all transport airplanes. ARAC has determined, and the FAA concurs, that there is no technical justification for limiting the applicability of any of the fuel tank protection provisions based on a passenger seating capacity.

Regulatory Evaluation Summary

Preliminary Regulatory Evaluation, Initial Regulatory Flexibility Determination, and Trade Impact Assessment

Proposed changes to Federal regulations must undergo several economic analyses. First, Executive Order 12866 directs that each Federal agency shall propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Second, the Regulatory Flexibility Act of 1980 requires agencies to analyze the economic effect of regulatory changes on small entities. Third, the Office of Management and Budget directs agencies to assess the effects of regulatory changes on international trade. In conducting these analyses, the FAA has determined that this rule: (1) would generate benefits that justify its costs and is not a "significant regulatory action" as defined in the Executive Order; (2) is not significant as defined in DOT's Regulatory Policies and Procedures; (3) would not have a significant impact on a substantial number of small entities; and (4) would not constitute a barrier to international trade. These analyses, available in the docket, are summarized below.

Regulatory Evaluation Summary

[To be completed]

Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities are not unnecessarily and disproportionately burdened by Federal regulations. The RFA requires agencies to determine whether rules would have "a significant economic impact on a substantial number of small entities," and, in cases where they would, to conduct a regulatory flexibility analysis. " FAA Order 2100.1 4A, Regulatory Flexibility Criteria and Guidance, prescribes standards for complying with RFA requirements in FAA rulemaking actions. The Order defines "small entities" in terms of size thresholds, "significant economic impact" in terms of annualized cost thresholds, and "substantial number" as a number which is not less than eleven and which is more than one-third of the affected small entities.

The proposed rule would affect manufacturers of transport category airplanes produced under future new airplane type certifications. For airplane manufacturers, FAA Order 2100.14A specifies a size threshold for classification as a small entity as 75 or fewer employees. Since no 14 CFR part 25 airplane manufacturer has 75 or fewer employees, the proposed rule would not have a significant economic impact on a substantial number of small airplane manufacturers.

International Trade Impact Assessment

The proposed rule would have no adverse impact on trade opportunities for U.S. manufacturers selling airplanes in foreign markets and foreign manufacturers selling airplanes in the U.S. market. Instead, by harmonizing the standards of the 14 CFR part 25 and the JAR 25, it would lessen restraints on trade.

Federalism Implications

The regulations proposed herein would not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government. Thus, in accordance with Executive Order 12612, it is determined that this proposal does not have sufficient federalism implications to warrant the preparation of a Federalism Assessment.

Conclusion

Because the proposed changes to the fuel tank crashworthiness requirements are not expected to result in any substantial economic costs, the FAA has determined that this proposed regulation would not be significant under Executive Order 12866. Because this is an issue that has not prompted a great deal of public concern, the FAA has determined that this action is not significant under DOT Regulatory Policies and Procedures (44 FR 11034; February 25, 1979). In addition, since there are no small entities affected by this rulemaking, the FAA certifies that the rule, if promulgated, would not have a significant economic impact, positive or negative, on a substantial number of small entities under the criteria of the Regulatory Flexibility Act, since none would be affected. A copy of the regulatory evaluation prepared for this project may be examined in the Rules Docket or obtained from the person identified under the caption "FOR FURTHER INFORMATION CONTACT."

List of Subjects in 14 CFR part 25

Air transportation, Aircraft, Aviation safety, Safety.

The Proposed Amendments

Accordingly, the Federal Aviation Administration (FAA) proposes to amend 14 CFR part 25 of the Federal Aviation Regulations (FAR) as follows:

PART 25 - AIRWORTHINESS STANDARDS: TRANSPORT CATEGORY AIRPLANES

1. The authority citation for Part 25 continues to read as follows:

Authority: 49 U.S.C. app. 1347, 1348, 1354(a), 1357 (d)(2), 1372, 1421 through 1430, 1432, 1442, 1443, 1472, 1510, 1522, 1652(e), 1655(c), 1657(f), 49 U.S.C. 106(g)

2. To amend Section 25.561 by adding paragraph 25.561 (c) to read as follows:

(c) For equipment, cargo in the passenger and cargo compartments and any other large masses, the following apply:

(1) Except as provided in paragraph (c)(2) of this section, these items must be positioned so that if they break loose, they will be unlikely to:

(i) Cause direct injury to occupants;

(ii) Penetrate fuel tanks or lines or cause fire or explosion hazard by damage to adjacent systems; or

(iii) Nullify any of the escape facilities provided for use after an emergency landing.

(2) When such positioning is not practical (e.g. fuselage mounted engines or auxiliary power units) each such item of mass shall be restrained under all loads up to those specified in paragraph (b)(3) of this section. The local attachments for these items should be designed to withstand 1.33 times the specified loads if these items are subject to severe wear and tear through frequent removal (e.g. quick change interior items). Cargo in cargo compartments located below or forward of all occupants in the airplane need comply only with c(1)(ii).

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3. To amend Section 25.721 to read as follows:

(a) The landing gear system must be designed so that when it fails due to overloads during take-off and landing the failure mode is not likely to cause spillage of enough fuel to constitute a fire hazard. The overloads must be assumed to act in the upward and aft directions - in combination with side loads acting inboard and outboard up to 20% of the vertical load or 20% of the drag load, whichever is greater.

(b) The airplane must be designed to avoid any rupture leading to the spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway, under the following minor crash landing conditions:

(1) Impact at 5 fps vertical velocity, with the airplane under control, at Maximum Design Landing Weight, all gears retracted and in any other combination of gear legs not extended.

(2) Sliding on the ground, all gears retracted up to a 20°yaw angle and as a separate condition, sliding with any other combination of gear legs not extended with 0° yaw.

(c) For configurations where the engine nacelle is likely to come in contact with the ground, the engine pylon or engine mounting must be designed so that when it fails due to overloads (assuming the overloads to act predominantly in the upward direction and separately predominantly in the aft direction), the failure mode is not likely to cause the spillage of enough fuel to constitute a fire hazard.

4. To amend Section 25.963 by revising paragraph 25.963(d) to read as follows:

(d) Fuel tanks must, so far as is practical, be designed, located, and installed so that no fuel is released, in quantities sufficient to start a serious fire, in otherwise survivable emergency landing conditions; and:

(1) Fuel tanks must be able to resist rupture and to retain fuel under ultimate hydrostatic design conditions in which the pressure P within the tank varies in accordance with the formula:

$$P=0.34*K*L$$

where:

P = fuel pressure in psi at each point within the tank

L = a reference distance in feet between the point of pressure and the tank farthest boundary in the direction of loading..

K = 4.5 for the forward loading condition for fuel tanks outside the fuselage contour.

K = 9 for the forward loading condition for fuel tanks within the fuselage contour

K = 1.5 for the aft loading condition

K = 3.0 for the inboard and outboard loading conditions for fuel tanks within the fuselage contour

K = 1.5 for the inboard and outboard loading conditions for fuel tanks outside of the fuselage contour

K = 6 for the downward loading condition

K = 3 for the upward loading condition

(2) Fuel tank internal barriers and baffles may be considered as solid boundaries if shown to be effective in limiting fuel flow.

(3) For each fuel tank and surrounding airframe structure, the effects of crushing and scraping actions with the ground should not cause the spillage of enough fuel, or generate temperatures that would constitute a fire hazard under the conditions specified in §25.721(b).

(4) Fuel tank installations must be such that the tanks will not be ruptured by an engine pylon or engine mounting or landing gear, tearing away as specified in 25.721(a) and (c).

5. To amend § 25.994 to read as follows:

Fuel system components in an engine nacelle or in the fuselage must be protected from damage which could result in spillage of enough fuel to constitute a fire hazard as a result of a wheels-up landing on a paved runway under each of the conditions prescribed in § 25.721(b).

Issued in Washington D.C. on